ENGLISH TRANSLATION OF INTERNATIONAL APPLICATION AS FILED

DESCRIPTION

LIGHTING DEVICE FOR DISPLAY DEVICES, LIQUID CRYSTAL DISPLAY DEVICE, AND LIGHT SOURCE LAMP

TECHNICAL FIELD

[0001]

The present invention relates to a lighting device for display devices, a liquid crystal display device, and a light source lamp. More specifically, the present invention relates to: a lighting device for display devices, preferably used for constituting a backlight of a transmissive or transflective liquid crystal display device having a transmissive region in a liquid crystal display element; a liquid crystal display device comprising such a lighting device for display devices; and a light source lamp.

BACKGROUND ART

[0002]

Lighting devices for display devices are devices for lighting a device having a display means using light, and have been widely used in backlight parts in liquid crystal display devices, for example. That is, a transmissive or transflective liquid crystal display device generally comprises a lighting device for display devices in a backlight part for making light enter a liquid crystal panel because liquid crystal panels themselves do not emit light in the liquid crystal display devices. Such liquid crystal display devices are essential for a means for displaying information or image. Products with high quality, fully taking advantage of characteristics of liquid crystal display, that is, low electric power consumption, lightweight, slimness, have been recently brought to attention in display panels such as monitors for consumer image, monitors for industrial equipment, and Personal Digital Assistants. And an

application field of such liquid crystal display devices is becoming more and more widespread.

[0003]

There are currently two types, edge light type (side light type) and direct type as backlights used in the liquid crystal display devices.

In the edge light type, a bar-shaped light source 72 such as cold cathode fluorescent tube is disposed on the side of a transparent plate 71 called a light guide plate, as shown in Fig. 8 as structural characteristics. In this case, light is made to enter the light guide plate 71 from the light source, and outputted from the inside of the light guide plate 71 to the liquid crystal panel 75 side by frosting process, printing, prism treatment, or the like. Thereby, the liquid crystal display device can be made thinner, but increase of the light source for increasing brightness directly affects thickness of a module. The so-called light guide plate 71 gets heavier in a large size of 20 or more inch because a heavy continuum such as acrylic continuum is used.

[0004]

In the direct type, a plurality of bar-shaped light sources 83 such as cold cathode fluorescent tube is provided on the back side of a display element 87 such as a liquid crystal panel, as shown in Fig. 9 as structural characteristics. In this case, light from the bar-shaped light source 83 is almost directly made to enter the display element 87. A diffusing plate 85 is often provided between the display element 87 and the light source 83 for eliminating an image of the bar-shaped light source 83. Thereby, the direct type backlight has the following advantages: many light sources 83 can be disposed; a light amount can be increased; loss of light is small because light is made to enter the display element 87 directly; and increase in size more than 20 inch can be easily provided. However, the number of the light sources 83 increases and thereby the number of components increases. Thereby, the driving circuit of the light source

83 becomes larger. Furthermore, the electric power consumption also increases, and the total amount of heating becomes larger.

[0005]

Such liquid crystal display devices began to advance in small display elements, and have been spread as displays for laptop PCs or cellular phones. Thus, the technique has been developed. In these fields, a display size up to about 15 inch is mainstream size, and reduction in thickness is a required condition. An edge light type has been selected in terms of merchantability.

Such liquid crystal display devices currently have become dramatically larger because of completion of a process using a larger mother glass, and thereby have established a position as a household television (20 to 50 inch). For such TVs, brightness is more important basic performance than required for PCs or cellular phones. For example, a PC monitor generally has about 250 cd/m^2 of specification value, but a brightness specification of 500 cd/m^2 or more is needed for TVs. Because of such backgrounds, a direct type backlight is preferable for providing a large backlight with high brightness.

[0006]

As conventional lighting devices for display devices, disclosed is a lighting device in which, in a liquid crystal display device using a direct type backlight, a frame side wall in the direction intersecting with a backlight (linear light source) or a frame between the linear light sources is sloped, and thereby reduction in brightness at both end edges of the linear light source is compensated to light a liquid crystal panel with uniform brightness distribution (for example, referring to Patent Document 1). Also disclosed is a lighting structure of a liquid crystal TV in which a U-shaped, S-shaped, or M-shaped fluorescent tube is disposed on the back side of a liquid crystal panel (for example, referring to Patent Document 2).

However, such devices have room for improvement in order

to properly correspond to a liquid crystal field and the like, needed for high quality and increase in size for improvement in merchantability and for low costs. And such lighting devices have room for improvement, in their structural characteristics, so as to have advantages in the production by reducing the number of components; to be effective in electric power consumption when applied to a liquid crystal display device; to have high quality and merchantability; and additionally to have improved these properties especially in development of a liquid crystal TV and the like.

[Patent document 1]

Japanese Kokai Publication Hei-11-84377 (pages 1 to 2)

[Patent document 2]

Japanese Kokai Publication Sho-62-102226 (pages 1 to 4)

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007]

The present invention has been made in view of the above-mentioned state of the art. The present invention has an object to provide: a lighting device for display devices which has the reduced number of components and is effective in terms of electric power consumption and can provide excellent display quality; a liquid crystal display device comprising such a lighting device for display devices; and a light source lamp.

MEANS FOR SOLVING THE PROBLEMS

[0008]

The present inventors have made various investigations about lighting devices for display devices, preferably applied to a backlight of a liquid crystal display device, for example, about large lighting devices for display devices with high brightness. They have firstly noted that a lighting device for display devices, comprising a light source lamp having a curved part, such as U-shaped tube, and a light-diffusing layer is

effective as a backlight constituting a liquid crystal display device and the like. If a U-shaped tube is used, for example, the number of components of a light source unit is reduced by half because one U-shaped tube corresponds to two straight tubes. Therefore, the number of components can be dramatically reduced. There is a correlation between electric power consumption of a conventionally used cold cathode fluorescent tube and a voltage drop graph, as shown in Fig. 10. Therefore, reduction in the number of electrodes due to the U-shaped tube makes it possible to reduce electric power consumption dramatically. That is, the voltage drop of the cold cathode is mostly determined by work function of a metal, and therefore reduction in the number of electrodes is effective for reduction in electric power consumption. In this case, one U-shaped tube corresponds to two straight tubes. The number of electrodes is reduced by half although the total length of a light source 83 is the same. If such a lighting device for display devices, comprising a light source lamp having a curved part and further a light-diffusing layer is used, the lighting device is preferable as a direct type backlight and advantageous particularly for increase in size.

The present inventors also have noted that the same effect as in the U-shaped tube can be obtained even in a light source lamp having a folded part, for example, a light source lamp having a structure similar to the U-shaped tube, the structure having two bending parts and a straight part between the bending parts (hereinafter, also referred to as "almost U-shaped tube"), other than the U-shaped tube having the curved part.

[0009]

A display device in which a straight tube CCFT (Cold Cathode Fluorescent Tube) is used in a direct type backlight and a display device in which a U-shaped tube or an almost U-shaped tube is used in a direct type backlight are compared. In the straight tube, the light source density in the plane of the display device becomes uniform if pitches between lamps 83 are the same as shown

in Fig. 11-a, and the light distribution property, which is a property of light diffusion, becomes uniform naturally in the plane. However, in the U-shaped tube or the almost U-shaped tube, display unevenness is generated in a region surrounded by dotted lines, shown in Figs. 11-b and 11-c. This would be because only the region surrounded by the dotted lines has an extraordinarily high light source density and therefore obviously becomes brighter, which leads to display unevenness. Also this would be because the light sources face lengthwise in the region surrounded by the dotted lines and therefore the light distribution property is also different from that in other regions, and thereby the region is recognized as more clear display unevenness if viewing angles are swung and the region is viewed.

Because of the above, the present inventors have noted that a lighting device comprising: a light source lamp having a folded part (curved part), such as U-shaped tube or almost U-shaped tube, the light source lamp being preferable in a direct type backlight; and a light-diffusing layer, is preferably used in a display device needed for high quality, such as TV, and that if, in this case, display unevenness can be suppressed enough, such a lighting device can be higher in quality and merchantability. They have found that such a lighting device for display devices having a constitution in which at least part of light generated from the folded part (curved part) of the light source lamp is reduced or shielded is preferable. Thereby, the above-mentioned problems have been solved without deterioration of specific advantages of the U-shaped tube, the almost U-shaped tube, or the like, leading to completion of the present invention.

[0010]

That is, the present invention is a lighting device for display devices, comprising a light source lamp and a light-diffusing layer, the light source lamp having a curved part, and at least part of light generated from the curved part

of the light source lamp being reduced or shielded.

The present invention is also a lighting device for display devices, comprising a light source lamp and a light-diffusing layer, the light source lamp having a folded part, and at least part of light generated from the folded part of the light source lamp being reduced or shielded.

The present invention is described below in more detail.

[0011]

The lighting device for display devices of the present invention comprises a light source lamp and a light-diffusing layer. Such a lighting device is preferable as a lighting device for liquid crystal display devices. In the present invention, the lighting device for display devices of the present invention is preferably used as a direct type backlight. The lighting device for display devices can be also applied to an edge light type backlight.

A configuration in which a light source lamp is disposed above a reflective sheet with a lamp supporting part therebetween, and the like, is mentioned as the above-mentioned lighting device in a direct type. One or a plurality of light source lamps is used in such a configuration. The present invention is preferably applied to a configuration using a plurality of light source lamps. In an edge light type, mentioned is a configuration in which a light source lamp is disposed on one or two or more sides of a light guide plate made of a transparent resin with a lamp supporting part therebetween. In the present description, the terms "or more" and "or less" means that the value described is included.

[0012]

Fluorescent tubes such as cold cathode fluorescent tube and hot cathode fluorescent tube are preferably used as the above-mentioned light source lamp, for example. In the present invention, the light source lamp essentially comprises a folded part (curved part). A U-shaped light source lamp is preferably used as the light source lamp having a curved part. In addition,

an S-shaped light source lamp or a W-shaped light source lamp may be mentioned. A light source lamp having a folded part having two or more bending parts and a straight part between the bending parts is preferably used. Among them, particularly preferably used is a light source lamp having a structure similar to the U-shaped tube, the structure having two bending parts and a straight part between the bending parts, that is, an almost U-shaped light source lamp (pseudo-U-shaped light source lamp) in which the U-shaped curved part of the U-shaped light source lamp is replaced with a folded part having a square U shape similar to the U shape. Due to such configurations, the number of components is reduced and also a total number of electrodes of the light source lamp is reduced. Thereby, electric power consumption on the whole of the lighting device for display devices can be reduced. If the U-shaped tube, the pseudo-U-shaped tube, or the like, is used, electrodes of the light source lamp are disposed on one side, which permits aggregation of the drive circuit on one side. On the other hand, if an S-shaped tube, a pseudo-S-shaped tube, or the like, is used, electrodes of the light source lamp are disposed on both sides, which is advantageous for uniformity of optical property in light outputted from the light source lamp.

A preferable configuration of the above-mentioned light source lamp in view of light uniformity is a configuration in which the straight part except for the curved part or the folded part of the light source lamp is disposed with equally spaced parallel to each other in the same plane.

[0013]

The above-mentioned light-diffusing layer is constituted by a diffusing plate or a diffusing sheet, and provided for eliminating an image of the light source lamp to provide display.

As long as the lighting device of the present invention comprises these essential constituting members, it may include other constitutional members.

If the above-mentioned lighting device is applied to a

liquid crystal display device, the lighting device is generally constituted by disposing a light source lamp above a reflective sheet and laminating and disposing various optical sheets such as diffusing plate, diffusing sheet, condenser lens sheet, polarized light selective reflection/transmission sheet, protective and diffusing sheet, and electromagnetic-shielding sheet (electric conductive sheet, ITO sheet). Then, such a lighting device constitutes a liquid crystal display device together with a liquid crystal panel.

[0014]

In the lighting device for display devices of the present invention, at least part of light generated from the folded part (curved part) of the light source lamp is reduced or shielded. Thereby, display unevenness attributed to light source density and light distribution property can be suppressed, and excellent display quality can be obtained without deterioration of specific advantages of the U-shaped tube, the pseudo-U-shaped tube, or the like.

In the present invention, at least part of light generated from the folded part (curved part) of the light source lamp is reduced or shielded. For example, in the curved part, it is preferable that light is reduced or shielded at a part outside the top of the inner radius of a curved part of a light source lamp 11 as shown in Fig. 6-a, or at a part outside the curve beginning of the curved part of the light source lamp 11 as shown in Fig. 6-b. In the folded part other than the curved part, it is preferable that light is reduced or shielded at a straight part between bending parts of a folded part of a light source lamp 11 as shown in Fig. 7-a, or at both of the bending parts and the straight part constituting the folded part as shown in Fig. 7-b. The part which is light-reduced or light-shielded is shown by hatched lines in these figures.

[0015]

Preferable configurations of the above-mentioned lighting device for display devices are (1) a configuration in

which at least part of the folded part (curved part) of the light source lamp is covered with a lamp frame; (2) a configuration in which the lighting device has an optical member provided with a light-reducing or light-shielding treatment on a display side of at least part of the folded part (curved part) of the light source lamp; (3) a configuration in which the lighting device has at least part of the folded part (curved part) of the light source lamp outside an effective display region; (4) a configuration in which at least part of the folded part (curved part) of the light source lamp is provided with a light-reducing or light-shielding treatment; (5) a configuration in which the lighting device has a reflective member provided with a light-reducing treatment on a side opposed to the display side of at least part of the folded part (curved part) of the light source lamp. In any of these configurations or combination of these configurations, functional effects of the present invention can be sufficiently exhibited.

[0016]

The means for reducing or shielding light from the folded part (curved part) of the light source lamp in the above-mentioned (1) to (5) configurations may be a means capable of reducing or shielding transmission of light. A resin frame capable of reducing or shielding light and the like, is preferably used if the lamp frame is used, for example. If the optical member is used, the optical member provided with the light-reducing or light-shielding treatment is preferably at least one optical member selected from the group consisting of a diffusing plate, a diffusing sheet, and a lens sheet. That is, preferable are a configuration in which the light-reducing or light-shielding treatment is provided for a diffusing plate, a configuration in which the light-reducing or light-shielding treatment is provided for a diffusing sheet, and a configuration in which the light-reducing or light-shielding treatment is provided for a lens sheet. A configuration in which these configurations are combined may be mentioned. These optical members can be

easily provided with the light-reducing or light-shielding treatment. Among them, it is preferable that part of the optical sheet such as diffusing plate, diffusing sheet, and lens sheet above (on the display side) at least part of the folded part (curved part) of the light source lamp is provided with the light-reducing treatment, by being colored for reduction in amount of light transmission, or by being whitened for light reflection to the light source lamp side. Mentioned may be a configuration in which a member for reducing or shielding light is provided for at least part of the folded part (curved part), and a configuration in which a coating material is applied by printing or the like, as a way of providing the light source lamp with the light-reducing or light-shielding treatment, if at least part of the folded part (curved part) of the light source lamp is provided with the light-reducing or light-shielding treatment. Among them, it is preferable that the light-reducing or light-shielding treatment has a function of restricting deformation degree of freedom in the folded part (curved part) of the light source lamp. If a member for reducing or shielding light or a coating film formed of a coating material has such a function, for example, the folded part (curved part) having the lowest strength can be protected, and breakage of the light source lamp, caused by the deformation, can be avoided. Therefore, handling of the light source lamp can be extremely significantly improved. In the U-shaped tube or the pseudo-U-shaped tube, for example, it is preferable that a light source holder such as a rubber having a shape covering the U-shaped curved part or the square U-shaped part is provided. If the reflective member is used, the reflective member provided with the light-reducing treatment is preferably a reflective sheet, and thereby can be easily provided with the light-reducing or light shielding treatment. If a white reflective sheet for reflecting light from the light source lamp to the display side is used, for example, it is preferable that part of the reflective sheet under (on the side opposed to the display side) at least

part of the folded part (curved part) of the light source lamp is provided with the light-reducing treatment by being colored for reduction in light reflective amount. It is preferable that the light-reducing or light-shielding treatment is provided by printing in the above configurations (2), (4), and (5). The use of printing makes it possible to perform the treatment easily and inexpensively. Further, it is preferable that a gradation in which degree of light reduction is varied, is provided in the light-reducing treatment in the above configurations (2), (4), and (5). If the gradation is provided in the light-reducing treatment, more preferable display quality can be obtained. Particularly, the use of printing makes it possible to provide the gradation very easily.

[0017]

The present invention is also a liquid crystal display device comprising the above-mentioned lighting device for display devices. Such a liquid crystal display device is a transmissive or transflective liquid crystal display device in which the use of the light source lamp having the curved part or the folded part, such as the U-shaped tube and the pseudo-U-shaped tube, makes it possible for such a liquid crystal display device to have the reduced number of components and to be effective in terms of electric power consumption; functional effects can be exhibited, for example, display unevenness can be suppressed and excellent display quality can be obtained, without deterioration of specific advantages of the light source lamp such as the U-shaped tube and the pseudo-U-shaped tube; and a structure capable of effectively and simply storing the light source lamp is included. And such a liquid crystal display device can be effectively used for display panels, for example, monitors for consumer image, monitors for industrial equipment, and Personal Digital Assistants.

The present invention is furthermore a light source lamp used in the above-mentioned lighting device for display devices. That is, the present invention includes a light source lamp

designed so as to adapt to the above-mentioned lighting device for display devices, and such a light source lamp exhibits functional effects advantageous in the above-mentioned display device field.

EFFECTS OF THE INVENTION

[0018]

The lighting device for display devices of the present invention has the above-mentioned configuration. The light source lamp has the folded part (curved part). Therefore, the number of component can be reduced, and the number of electrodes also can be reduced, leading to reduction of electric power consumption. At least part of light generated from the folded part (curved part) of the light source lamp is reduced or shielded. Thereby, the light source density and the light distribution property are made uniform in the effective display region. Therefore, the display unevenness can be suppressed and a display device excellent in display quality can be provided.

BEST MODE FOR CARRYING OUT THE INVENTION

[0019]

The present invention will, hereinafter, be described in more detail with reference to Embodiments, but the present invention is not limited to Embodiments.

[Embodiment 1]

[0020]

Figs. 1-a and 1-b each show a configuration in which the above-mentioned preferable configuration (1) of the present invention is applied to a lighting device of a direct type liquid crystal display device. In this configuration, the lighting device for liquid crystal display devices has a structure in which part of or all of a curved part of a light source lamp 11 is covered with a lamp frame 84 capable of reducing or shielding light, and is constituted such that part of or all of the curved part of the light source lamp 11 is stored in the lamp frame

84 conventionally used.

In this case, the lighting device has a constitution in which the U-shaped curved part of the U-shaped tube is covered with the lamp frame, and thereby the same optical property as in the case where a straight tube is used can be provided. Thereby, the lamp frame reduces or shields light at the U-shaped curved part of the U-shaped tube without deterioration of specific advantages of the U-shaped tube, and therefore the same light source density and light distribution property as in the straight part of the light source lamp is exhibited. Therefore, the light source density in the plane is uniformized and the light distribution property is also uniformized, which makes it possible to provide excellent display quality.

As a direct type liquid crystal display device constituted by the lighting device for display devices of the present invention, mentioned may be, for example, a liquid crystal display device having a structure in which a highly reflective resin 82 is disposed on a sheet metal 81, and thereon a U-shaped tube 11 in which the ends are covered with an insulating resin is disposed using a storage frame (lamp frame) 84, and a diffusing plate 85, and thereon various optical sheets 86 such as diffusing sheet, condenser lens, polarized light selective reflection/transmission sheet, protective and diffusing sheet, and electromagnetic-shielding sheet (electric conductive sheet, ITO sheet), a liquid crystal panel element 87, and a frame 88 are disposed.

[Embodiment 2]

[0021]

Figs. 2-a and 2-b each show a configuration in which the above-mentioned preferable configuration (2) of the present invention is applied to a lighting device of a direct type liquid crystal display device. In this configuration, the lighting device has a structure in which the lighting device has an optical member 21 provided with the light-reducing or light-shielding treatment on the display side of part of or all of a curved part

of a light source lamp 11. The optical member 21 provided with the light-reducing or light-shielding treatment may be a diffusing plate, a diffusing sheet, or the like, each provided with a region with low light transmittance 21a. Among them, an optical member disposed near the light source is preferable for sufficient light-reducing or light-shielding effect in the oblique direction. The region with low light transmittance 21a can be formed by applying white ink to the surface of the optical member 21 on the light source lamp side. In this case, light reflectance to the light source lamp 21 side is high, and therefore loss of light can be reduced. An opening for light transmission may be provided at part of the region with low light transmittance 21a. In this configuration, the optical member 21 is laminated and disposed above the light source lamp 11 such that part of or all of the curved part of the light source lamp 11 is covered with the part provided with the light-reducing or light-shielding treatment of the optical member 21, and thereby the lighting device for liquid crystal display devices is configured.

In this case, the lighting device has a constitution in which the U-shaped curved part of the U-shaped tube is covered with the optical member, and thereby the same optical property as in the case where a straight tube is used can be provided. Thereby, excellent display quality can be provided without deterioration of specific advantages of the U-shaped tube.

[Embodiment 3]

[0022]

Fig. 3 shows a configuration in which the above-mentioned preferable configuration (3) of the present invention is applied to a lighting device of a direct type liquid crystal display device. In this configuration, the lighting device for liquid crystal display devices is configured to have a structure in which part of or all of a curved part of a light source lamp 11 is disposed outside an effective display region 31. In this case, the lighting device has a constitution in which the U-shaped curved part of the U-shaped tube is disposed outside the effective

display region, and thereby the same optical property as in the case where a straight tube is used can be provided. Thereby, excellent display quality can be provided without deterioration of specific advantages of the U-shaped tube.

[Embodiment 4]

[0023]

Fig. 4 shows a configuration in which the above-mentioned preferable configuration (4) of the present invention is applied to a lighting device of a direct type liquid crystal display device. In this configuration, the lighting device for liquid crystal display devices is configured to have a structure in which a member for reducing or shielding light 41 is provided with part of or all of a curved part of a light source lamp 11. A member made of a material with low light transmittance, preferably made of an elastic material is preferably used as the member for reducing or shielding light 41.

In this case, the lighting device has a constitution in which the U-shaped curved part of the U-shaped tube is covered with the member for reducing or shielding light, and thereby the same optical property as in the case where a straight tube is used can be provided. Thereby, excellent display quality can be provided without deterioration of specific advantages of the U-shaped tube. The U-shaped curved part can be prevented from opening and closing, and the U-shaped tube can be effectively fixed by covering the U-shaped curved part of the U-shaped tube with the member for reducing or shielding light.

[Embodiment 5]

[0024]

Fig. 5 shows a configuration in which the above-mentioned preferable configuration (5) of the present invention is applied to a lighting device of a direct type liquid crystal display device. In this configuration, the lighting device has a structure in which the lighting device has a reflective member provided with a light-reducing treatment 51 on the side opposed to the display side of part of or all of a curved part of a light

source lamp 11, and is constituted such that part of or all of the curved part of the light source lamp 11 is provided above a region provided with a light-reducing treatment 51a of the reflective member 51. The reflective member provided with a light-reducing treatment 51 may be a reflective sheet with which the region with low light reflectance 51a which is gray, black, or the like, is provided.

In this case, the lighting device has a constitution in which the U-shaped curved part of the U-shaped tube is provided above the region provided with the light-reducing treatment, and thereby the same optical property as in the case where a straight tube is used can be provided. Thereby, excellent display quality can be provided without deterioration of specific advantages of the U-shaped tube.

[Embodiment 6]

[0025]

In Embodiment 6, the U-shaped light source lamp in Embodiment 1 is replaced with a pseudo-U-shaped light source lamp having a square U-shaped folded part. That is, in this configuration, the lighting device has a structure in which part of or all of the square U-shaped part of the light source lamp is covered with a lamp frame capable of reducing or shielding light, and is constituted such that part of or all of the square U-shaped part of the light source lamp is stored in a conventionally used lamp frame. Therefore, the same functional effects as in Embodiment 1 can be obtained in Embodiment 6.

[Embodiment 7]

[0026]

In Embodiment 7, the U-shaped light source lamp in Embodiment 2 is replaced with a pseudo-U-shaped light source lamp having a square U-shaped folded part. That is, in this configuration, the lighting device for liquid crystal display devices is configured by laminating and disposing an optical member above the light source lamp such that part of or all of the square U-shaped part of the light source lamp is covered

with the part provided with the light-reducing or light-shielding treatment of the optical member. Therefore, the same functional effects as in Embodiment 2 can be exhibited in Embodiment 7.

[Embodiment 8]

[0027]

In Embodiment 8, the U-shaped light source lamp in Embodiment 3 is replaced with a pseudo-U-shaped light source lamp having a square U-shaped folded part. That is, in this configuration, the lighting device for liquid crystal display devices is configured to have a structure in which part of or all of the square U-shaped part of the light source lamp is disposed outside an effective display region. Therefore, the same functional effects as in Embodiment 3 can be obtained in Embodiment 8.

[Embodiment 9]

[0028]

In Embodiment 9, the U-shaped light source lamp in Embodiment 4 is replaced with a pseudo-U-shaped light source lamp having a square U-shaped folded part. That is, in this configuration, the lighting device for liquid crystal display devices is configured to have a structure in which a member for reducing or shielding light is provided with part of or all of the square U-shaped part of the light source lamp. Therefore, the same functional effects as in Embodiment 4 can be obtained in Embodiment 9.

[Embodiment 10]

[0029]

In Embodiment 10, the U-shaped light source lamp in Embodiment 5 is replaced with a pseudo-U-shaped light source lamp having a square U-shaped folded part. That is, in this configuration, the lighting device has a structure in which the lighting device has a reflective member provided with the light-reducing treatment on the side opposed to the display side of part of or all of the square U-shaped part of the light source lamp, and part of or all of the square U-shaped part of the light

source lamp is disposed above the region provided with the light-reducing treatment of the reflective member. Therefore, the same functional effects as in Embodiment 5 can be obtained in Embodiment 10.

[0030]

The present application claims priority under 35 U.S.C. § 119(a) on Japanese Patent Application No. 2004-3076 filed in Japan on January 8, 2004, entitled "LIGHTING DEVICE FOR DISPLAY DEVICES, LIQUID CRYSTAL DISPLAY DEVICE AND LIGHT SOURCE LAMP", the entire contents of which are herein incorporated by reference.

BRIEF DESCRIPTION OF THE DRAWING

[0031]

[Figure 1-a]

Fig. 1-a is a plane view schematically showing a configuration of a direct type liquid crystal display device to which the lighting device of the present invention is applied, the lighting device having a structure in which at least part of the curved part of the light source lamp is covered with a lamp frame.

[Figure 1-b]

Fig. 1-b is a cross-sectional view schematically showing the lighting device in Fig. 1-a.

[Figure 2-a]

Fig. 2-a is a plane view schematically showing a configuration of a direct type liquid crystal display device to which the lighting device of the present invention is applied, the lighting device having an optical member provided with a light-reducing or light-shielding treatment on the display side of at least part of a curved part of a light source lamp.

[Figure 2-b]

Fig. 2-b is a cross-sectional view schematically showing the lighting device in Fig. 2-a.

[Fig. 3]

Fig. 3 is a plane view schematically showing a configuration of the lighting device of the present invention, the lighting device having at least part of the curved part of the light source lamp outside an effective display region.

[Fig. 4]

Fig. 4 is a plane view schematically showing a light source lamp in which at least part of the curved part is provided with a member for reducing or shielding light in the lighting device of the present invention.

[Fig. 5]

Fig. 5 is a plane view schematically showing a configuration of the lighting device of the present invention, the lighting device having a reflective member provided with a light-reducing treatment on the side opposed to the display side of at least part of a curved part of a light source lamp.

[Figure 6-a]

Fig. 6-a is an enlarged plane view schematically showing the curved part of the light source lamp.

[Figure 6-b]

Fig. 6-b is an enlarged plane view schematically showing the curved part of the light source lamp.

[Figure 7-a]

Fig. 7-a is an enlarged plane view schematically showing the folded part of the light source lamp.

[Figure 7-b]

Fig. 7-b is an enlarged plane view schematically showing the folded part of the light source lamp.

[Fig. 8]

Fig. 8 is a cross-sectional view schematically showing essential parts of a structure of an edge light type backlight.

[Fig. 9]

Fig. 9 is an exploded perspective view schematically showing essential parts of a structure of a direct type backlight.

[Fig. 10]

Fig. 10 is a graph showing the relationship between length

of a cold cathode fluorescent tube and voltage drop.

[Figure 11-a]

Fig. 11-a is a plane view schematically showing essential parts of a direct type backlight using a light source lamp having a straight tube shape.

[Figure 11-b]

Fig. 11-b is a plane view schematically showing essential parts of a direct type backlight using a light source lamp having a U-shaped tube shape.

[Figure 11-c]

Fig. 11-c is a plane view schematically showing essential parts of a direct type backlight using a light source lamp having an almost U-shaped tube shape.

EXPLANATION OF NUMERALS AND SYMBOLS

[0032]

11: Light source lamp (U-shaped tube)
21: Optical member provided with a light-reducing or light-shielding treatment
21a: Region having low light transmittance
31: Effective display region
41: Member for reducing or shielding light
51: Reflective member
51a: Region with which a light-reducing treatment is provided in the reflective member 51.
71: Light guide plate
72: Bar-shaped light source
73: Frame
74: Optical sheet
75: Liquid crystal panel
81: Sheet metal
82: Highly reflective resin
83: Bar-shaped light source
84: Storage frame (Lamp frame)
85: Diffusing plate

86: Optical sheet
87: Display element (liquid crystal panel element)
88: Frame